ISGAN SIRFN, Mission Innovation, Clean Energy Ministerial, CSIRO, & DERlab
"Grid Integration of Renewables – The Role of Research & Testing Facilities"
9th International Conference on the Integration of Renewable & Distributed Energy Resources
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How Can Testing Accelerate Renewable Energy Integration?

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Smart system validation platform

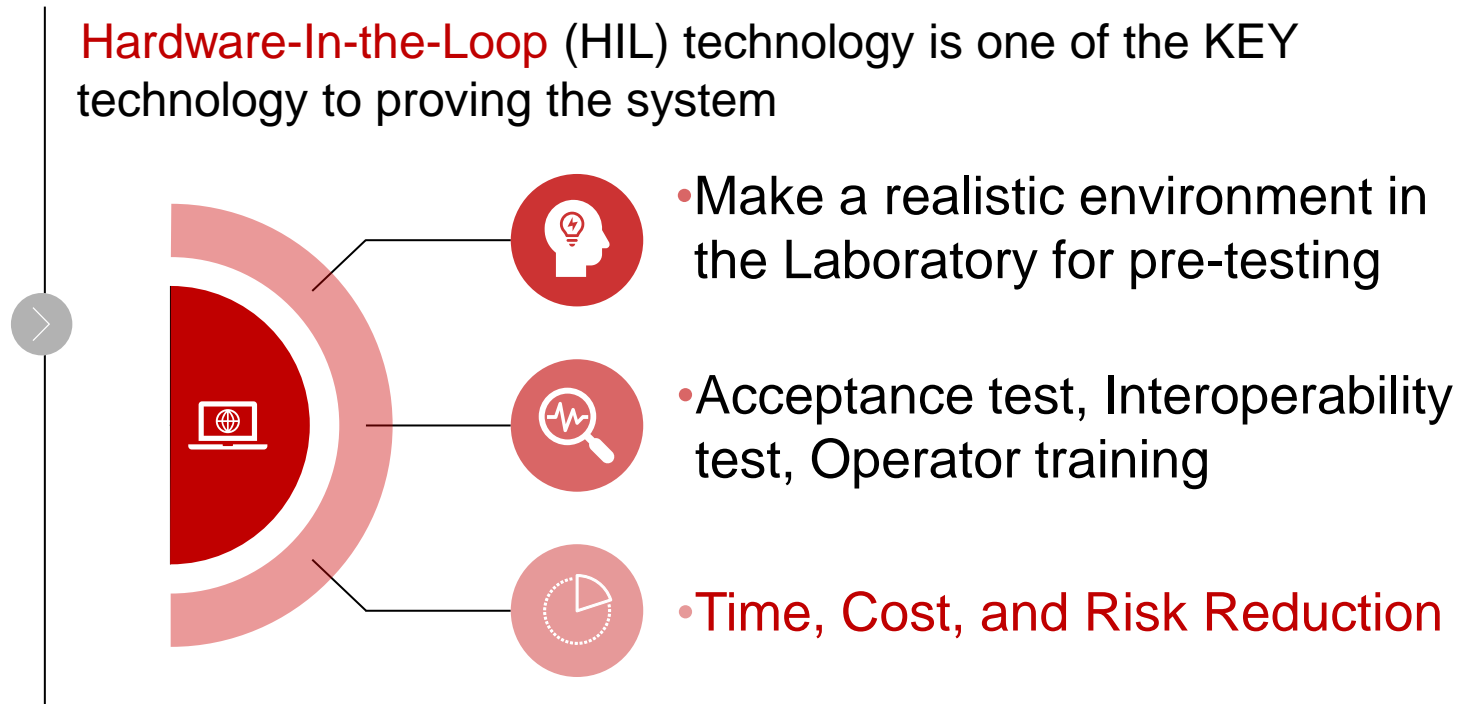**There are many demonstration projects for Smart Grid, Virtual power plants (VPP), etc.**

A holistic validation platform for a new concept is needed.

Hardware-In-the-Loop (HIL) technology is one of the KEY technology to proving the system

? Question is ;

Q How can we integrate each unique concepts to the market?

Q How can "Utility" and/or "Stakeholder" accept new concept to their system?

- Make a realistic environment in the Laboratory for pre-testing

- Acceptance test, Interoperability test, Operator training

- Time, Cost, and Risk Reduction

Platform to support the system development process

Manufacturer integrator ←···· **Data and Certification** ···· **Test lab**

Support R&D and accelerate RE integration each phase

Specification ←···· **Feedback to development** ···· **Commissioning Test**

Basic design ←···· **System test**

Detailed Design ←···· **Combination Test**

Integration ····→ **Component Test**

1 Support of design and operation data, construction of a database

2 Providing more sophisticated system-wide test methods

3 Ensuring Interoperability for Various Distributed Power Sources

4 Development and evaluation of various distributed power sources

⟫⟫⟫ System development process

Planning → Concept Design → Details Design → Manufacturing → Evaluation and verification

What is Hardware-in-the-Loop?

Physical testing

Virtual testing

DuT

Interaction

Device under Test (DuT)

Real / physical testing field

Interaction

Feedback

Device under Test (DuT)
<Hardware>
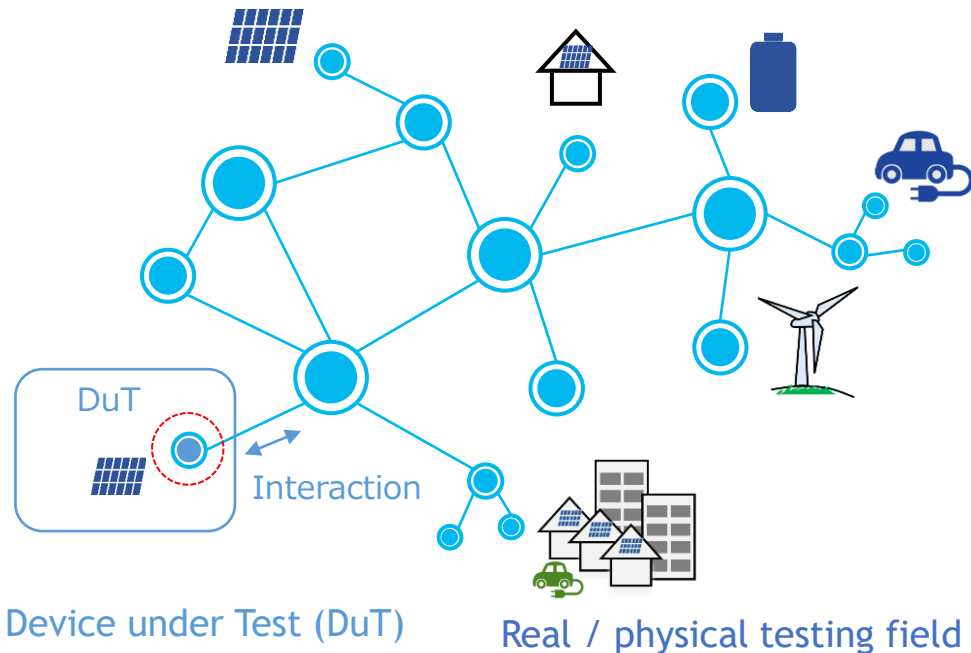
Digital Real Time Simulator (DRTS)
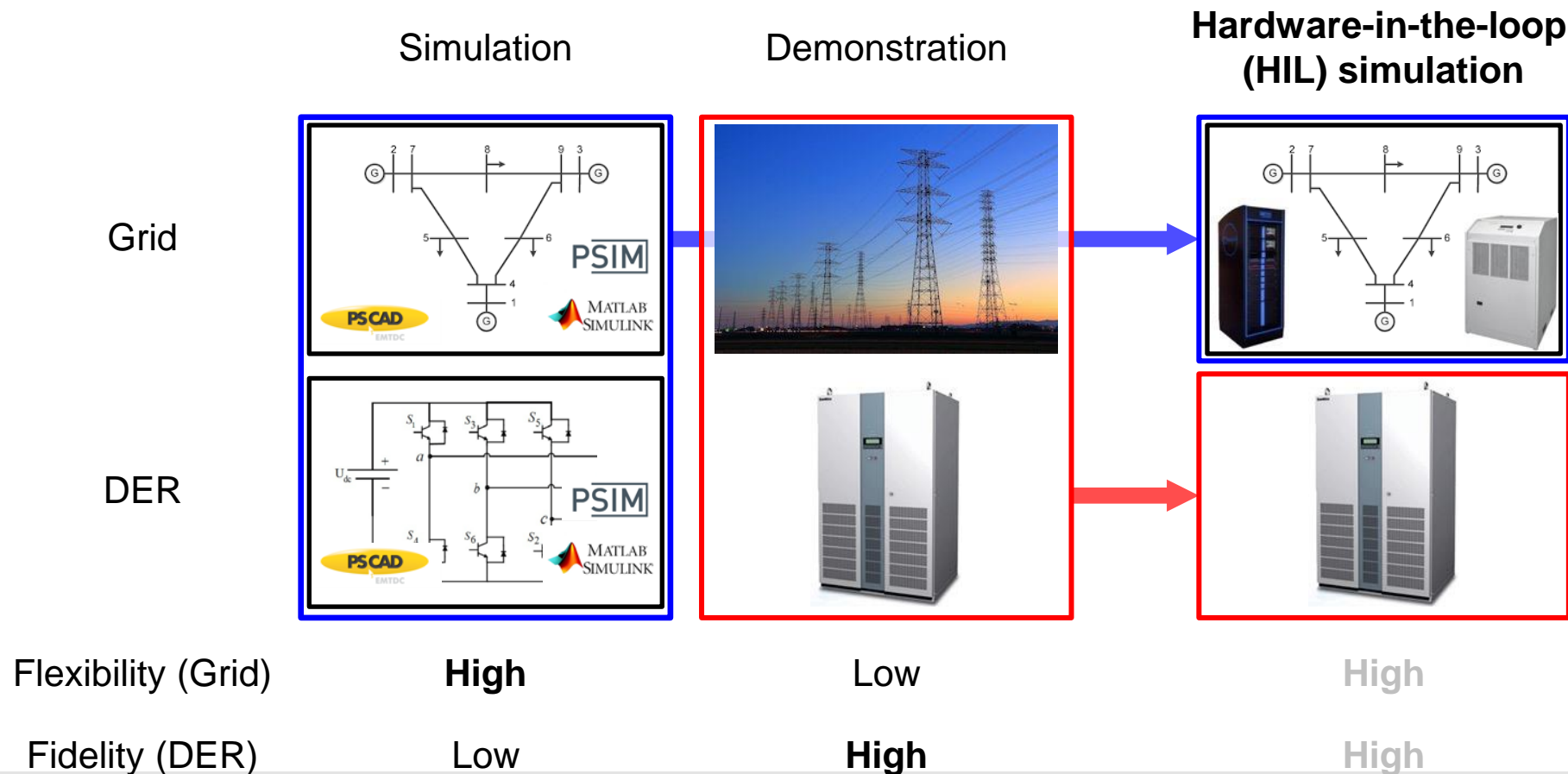<simulation>
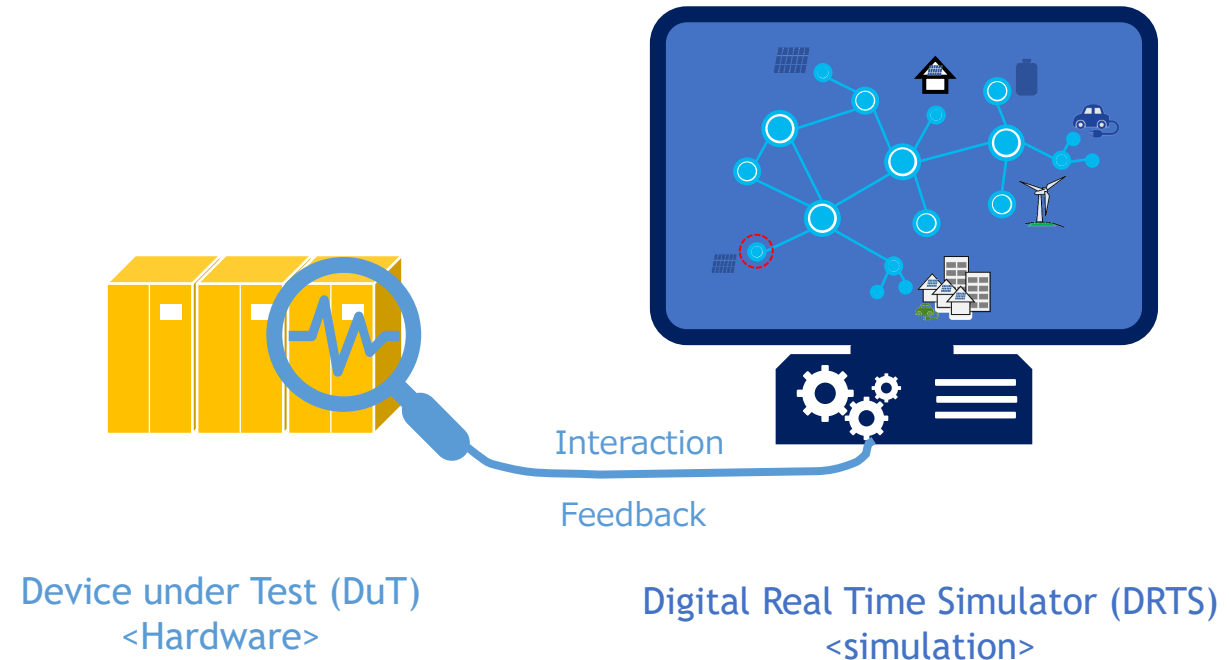
What is HIL?
- A simulator (DRTS) capable of simulating various systems in real-time and consisting of one or more DuTs.
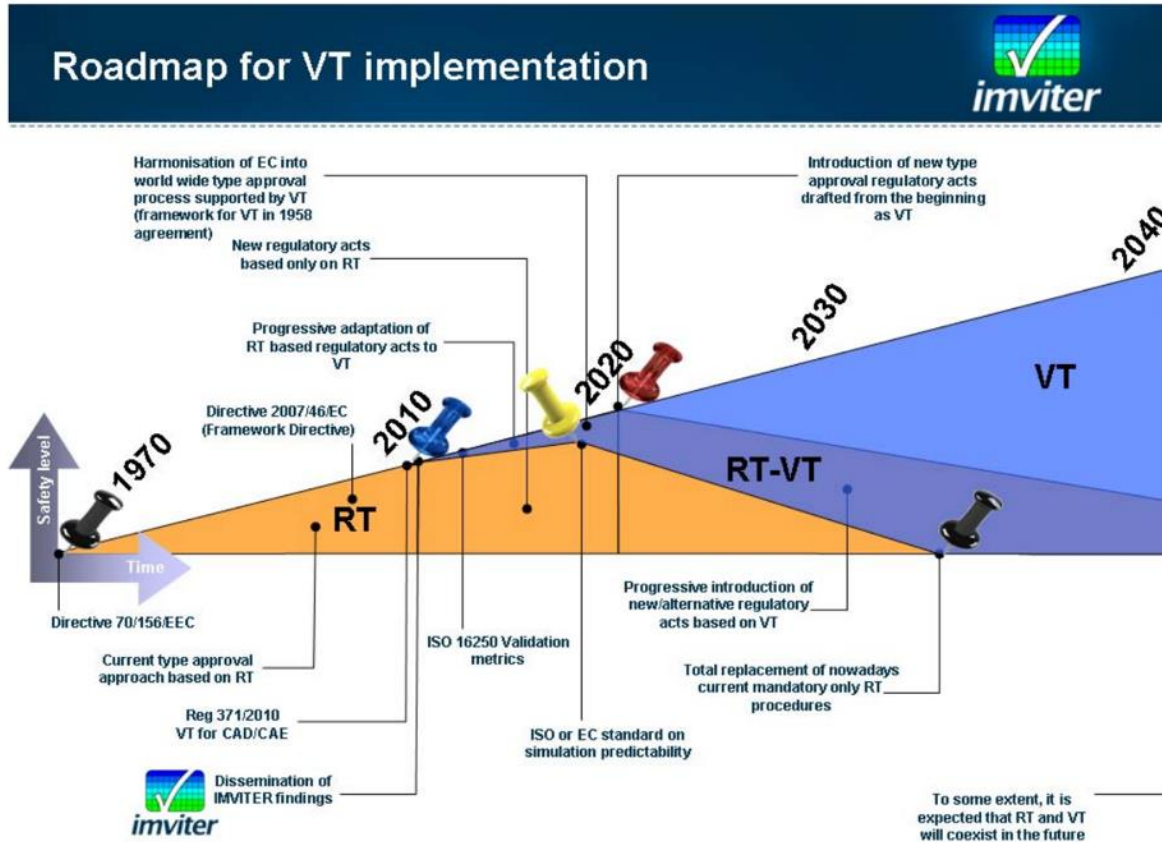
How its work?
- Control signals from the DuT are reflected in the virtual system in the DRTS, and the results are fed back to the DuT.
- DuT runs on the virtual system, allowing for easy testing and verification, including system interaction, etc.

More flexible testing method

- HIL is a well-known technology in the Automobile and aircraft sectors.

- This technology will be the key to future power systems and harmonization with Model Base Design (MBD) concept is necessary.

	Simulation	Demonstration	Hardware-in-the-loop (HIL) simulation
Grid			
DER			
Flexibility (Grid)	**High**	Low	High
Fidelity (DER)	Low	**High**	High

In Europe, accelerating to use of Virtual Testing for type certification

Virtual Testing based Type Approval Procedures for the Assessment of Pedestrian Protection developed within the EU-Project IMVITER
https://www-esv.nhtsa.dot.gov/Proceedings/23/files/23ESV-000344.PDF

First Draft Submitted to Allow Virtual Testing as an Alternative to Full-Scale Testing

UNECE WP29

Virtual Testing (VT) using simulation, HIL, etc. is discussed in VMAD (Validation Method for Automated Driving) under GRVA, a subcommittee of the Automated Driving Committee.

"Report from the Informal Working Group on AEBS," GRVA-09-26, 9th GRVA, 1-5 Feb. 2021, Agenda item 7 （https://unece.org/sites/default/files/2021-01/GRVA-09-26e.pdf）

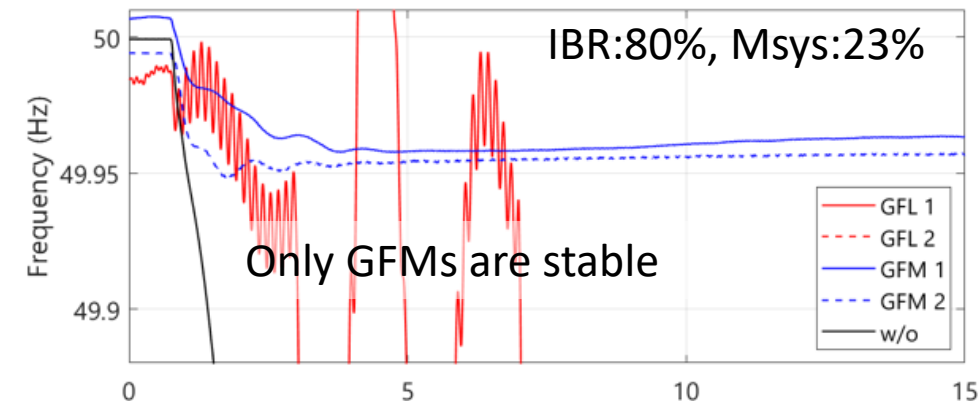# Example of acerating R&D of DER testing with PHIL

- Five prototype inverters are developed by manufacture in Japan.
- Different types of algorithm including GFM type are implemented to each device.
- Each device has been tested with PHIL.
  - IEEE Standard 9 bus system was used.
  - Over 200 test cases including generator trip and load trip events.

IBR:20%, Msys:92%

All inverter are stable

IBR:60%, Msys:46%

Legacy inverter is unstable

IBR:80%, Msys:23%

Only GFMs are stable
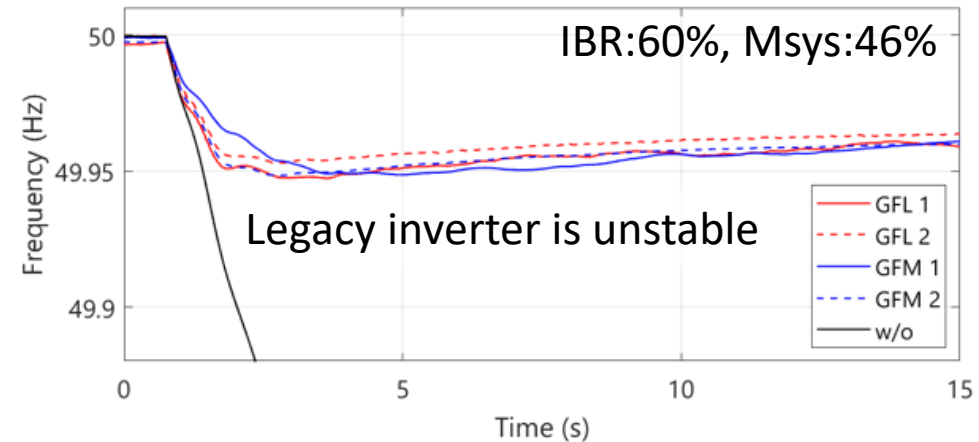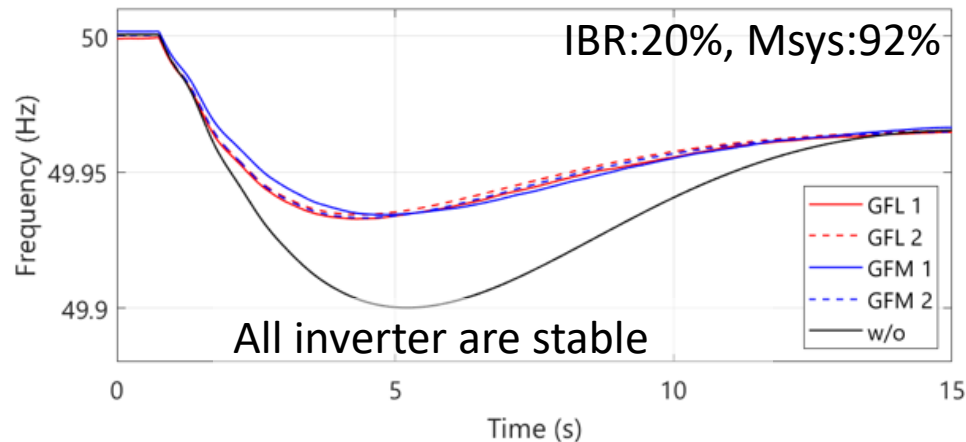
GFM/GFL inverter prototype with synthetic inertia capability

Msys is kinetic energy stored in a synchronous generator. The percentage of test case kinetic energy against to all synchronous generators case.

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Thank you!

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